

***I-77 Feasibility Study (I-85 to Griffith Street)***

***TIP Project No. FS-0810B***

**Task Order No. 2 – I-77 HOV/HOT Conversion  
Sub-task 2.E: Capital, Operations & Maintenance Costs**

# **TECHNICAL MEMORANDUM**

## **(FINAL)**

**February 2010**

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# 1.0 INTRODUCTION

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This memorandum details capital, operations and maintenance (O&M) cost assumptions and preliminary cost estimates for converting the existing I-77 high-occupancy vehicle (HOV) lanes to high-occupancy toll (HOT) lanes and extending this facility northward to Griffith Street in Davidson (Exit 30). The information contained in this memo has been collected from sources at the North Carolina Department of Transportation (NCDOT) and its business unit, the North Carolina Turnpike Authority (NCTA), which would be responsible for respective costs and operations.

O&M costs for the roadway and the tolling system, including additional costs that enhance the level of service on the facility, such as added safety and enforcement patrols, are covered in the following sections. Tolling system capital costs and expected future capital maintenance needs for both the tolling system and the roadway are also covered along with discussion on which of these costs would typically be covered by revenues generated from a HOT lane facility. For all scenarios, the costs presented in this memorandum represent what would be needed to maintain a level of service (including roadside assistance, roadway condition, and traffic flow) that exceeds the level typically maintained on State highways and interstates.

The corridor's existing HOV facility extends from Hambright Road to Oaklawn Avenue in the southbound direction and from Cindy Lane to I-485 in the northbound direction. It is possible that the HOT conversion of the existing HOV lanes will be performed and then extended to one of the exits north of I-485 based on traffic analysis. Because operational data will be presented for various scenarios, **Table 1-1** illustrates these options, showing the number of miles and tolling points in each alternative.

Each corridor scenario will have one HOT lane in each direction. The roadway layout for the HOT lane is assumed to be a narrow buffer-separated concurrent-flow system, meaning one dedicated lane will be available in each direction at all times and will be separated from general purpose lanes by pavement markings, as opposed to concrete or plastic "soft" barriers. Tolling points for the HOT lanes will be spaced about every one to two miles as ingress and egress points dictate.

**Table 1-1: Managed Lane System by Corridor**

	Per Segment		Cumulative	
	Lane Miles	Tolling Points*	Lane Miles	Tolling Points*
Existing HOV Conversion to HOT	13.2	6	13.2	6
Extension to Exit 25	10.5	4	23.7	10
Extension to Exit 28	5.8	2	29.5	12
Extension to Exit 30	3.0	2	32.5	14
<b>Total System</b>	<b>32.5</b>	<b>14</b>		

\* Designates a single directional tolling point

Construction of tolling gantries and Intelligent Transportation Systems (ITS) improvements, together with implementation of public informational campaigns, will be

undertaken in conjunction with the actual HOT lane construction and is expected to be complete prior to the system's opening.

To account for expected inflation, annual escalation rates of 3 percent and 5 percent are used for general and construction inflation, respectively. Unless otherwise noted, all figures presented in this memorandum were escalated or discounted to 2009 dollar terms. Contingencies to account for price fluctuations and unforeseen costs are assumed for roadway and tolling infrastructure costs at rates of 20 percent and 15 percent, respectively.

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## 2.0 CAPITAL COSTS

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### 2.1 CONSTRUCTION COSTS

#### 2.1.1 Roadway Construction Costs

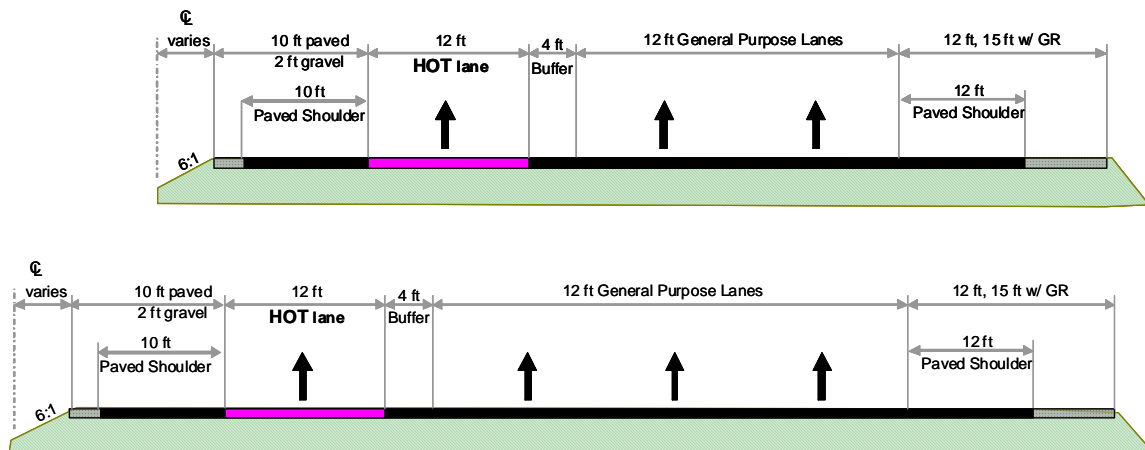
Based on the functional design, construction cost estimates for constructing I-77 HOT lanes used cost data from NCDOT's latest preliminary estimates construction cost index, and estimates are provided in current year dollars. NCDOT staff reviewed the construction cost estimates, projected major quantities, and unit prices.

Estimates were prepared for two build options analyzed under this task order:

- Extend a single HOT lane in each direction to Catawba Avenue (Exit 28). The designation of the proposed HOT lane would end about ½-mile south of Exit 28. Traffic in the northbound general purpose lanes would merge to the leftmost lane ensuring that HOT lanes users have priority when three northbound lanes are reduced to two lanes. The outside general purpose lane would drop at the exit ramp at the Catawba Avenue interchange. The southbound HOT lane would begin south of the causeway between Exits 28 and 30.
- Implement the above improvements and add another general purpose lane in each direction between I-485 and Catawba Avenue (Exit 28). This will provide four lanes in each direction and match the cross section where the HOV lane currently exists south of I-485. At Exit 28, the HOT lane would lose its designation and the outside general purpose lane would be dropped at the on-ramp for this interchange. Another general purpose lane would be dropped at Langtree Road (Exit 31) in order to match the existing I-77 lane configuration north of this interchange.

**Figure 2-1** compares the typical cross section in which just HOT lanes are built north of I-485 with the cross section that includes the addition of both the HOT lanes facility and general purpose lanes.

**Figure 2-1: Typical HOT Lane Cross Sections**



The following roadway design principles were assumed for I-77 improvements:

- Widening for both alternates will be in the median where space is available. Only when sufficient space is not available, additional widening will occur on the outside.
- Overlay of existing facility will be required as part of the construction of any new lanes.
- No design exceptions are required under either option. A minimum of 12-foot lanes will be used with standard shoulders.
- All existing interchange and overpass structures can remain.
- No additional right-of-way is needed for freeway widening.
- No significant impacts on utilities are anticipated.
- Signing will be implemented based on the latest MUTCD guidelines for HOT lanes.

### **2.1.2 Tolling System Capital Costs**

The tolling system consists of computer technology to operate and monitor the system and process transactions. Toll collection equipment, including the gantries, transponder readers, and information displays also fall into this cost category. This entire equipment package must be purchased and installed prior to the facility's opening, and like the roadway surface, it must be replaced periodically (capital maintenance). The initial system components and costs are discussed first, followed by periodic capital maintenance costs. Cost estimates assume that the system will be operated by NCDOT/NCTA, taking advantage of economies of scale and eliminating potential redundancies that would result from a standalone I-77 HOT lane operation.

**Computer System** – A typical computer system and software package to operate a HOT lane facility would cost between \$2 million and \$4 million, but will not be needed for I-77 because NCDOT/NCTA is assumed to operate the HOT lanes. The HOT lanes share of NCDOT/NCTA's costs for this equipment is embedded in the per-transaction variable processing cost that would be charged by NCDOT/NCTA, described later in this memorandum.

**Tolling Infrastructure** - Each tolling point cost has been calculated for one lane of travel, including one variable message sign, an open-road toll (ORT) reader, and one video tolling camera set. A small utility terminal which serves the tolling point and the gantries to hold this equipment are also included. A 15 percent contingency on these costs has been added to the tolling point cost, totaling about \$530,000 in 2009 dollars for each tolling point.

**ITS System** – The current ITS system in the corridor could be extended to serve the HOT lane facility, but it is assumed that a standalone ITS system is procured. Information from NCDOT was compiled for the ITS system components, and its estimated cost equals \$360,000 per mile. This cost estimate includes fiber optic cable, dynamic message signs (DMS) and related infrastructure, and system hubs. **Table 2-1** summarizes these costs for the various HOT lanes scenarios.

**Table 2-1: Tolling System Capital Costs (2009 Dollars)**

	Convert HOV to HOT	Extension to Exit 25	Extension to Exit 28	Extension to Exit 30	Total System
Tolling Equipment and Signage	\$ 2,497,200	\$ 1,664,800	\$ 832,400	\$ 832,400	\$ 5,826,800
ITS System Cost	\$ 2,169,200	\$ 1,668,200	\$ 921,500	\$ 476,600	\$ 5,235,500
Contingency (15%)	\$ 700,000	\$ 500,000	\$ 263,100	\$ 196,400	\$ 1,659,500
<b>Total Capital Cost</b>	<b>\$ 5,366,400</b>	<b>\$ 3,833,000</b>	<b>\$ 2,017,000</b>	<b>\$ 1,505,400</b>	<b>\$ 12,721,800</b>
<b>Cumulative Costs</b>	<b>\$ 5,366,400</b>	<b>\$ 9,199,400</b>	<b>\$ 11,216,400</b>	<b>\$ 12,721,800</b>	

Tolling and ITS system equipment will need to be replaced periodically. This equipment is assumed to have a 10-year life.

### **2.1.3 Total Capital Costs**

Preliminary cost estimates have been prepared using NCDOT's functional design cost estimate index. All estimates are based on the functional design prepared for each alternative. In addition, a signing plan was developed based on the latest MUTCD guidelines and included in the estimate. The following tables show cost breakdown as follows:

**Table 2-2** and **Table 2-3** summarize total costs estimated for the option of HOT lane construction only for two segments: 1) from current terminus of HOV facility north to NC-73 or Sam Furr Road (Exit 25) and 2) between Exit 25 and Catawba Avenue (Exit 28). All costs are expressed in 2009 dollars. The tolling equipment, signage and ITS costs presented in the previous section would have to be added to the estimates in these tables in order to estimate total costs for HOT lanes implementation.

**Table 2-4** and **Table 2-5** indicate estimated capital costs for the same two segments for the alternative which adds two lanes in both directions of I-77. The equipment estimates from Table 2-1 also must be added to provide total capital costs.

**Table 2-6**, shows that implementation of HOT lanes north of I-485 would cost between \$50 million and \$88 million depending on the selected alternative.

**Table 2-2: HOT Lane Extension Only (2009 Dollars)**  
(Mt. Holly-Huntersville Rd. to NC-73)

Line Item	Des	Sec No.	Description	Quantity	Unit	Price	Amount
			Clearing and Grubbing	50.2	Acre	\$ 12,000.00	\$ 602,400.00
			Earthwork	58,700	CY	\$ 8.00	\$ 469,600.00
			Drainage Existing Location	3.60	Miles	\$ 250,000.00	\$ 900,000.00
			Fine Grading	150,800	SY	\$ 1.50	\$ 226,200.00
			Pavement Widening	108,900	SY	\$ 52.00	\$ 5,662,800.00
			New Pavement	0	SY		\$ -
			Pavement Resurfacing	142,400	SY	\$ 7.00	\$ 996,800.00
			___ "Average Asphalt Wedging	0	SY		\$ -
			Subgrade Stabilization	108,900	SY	\$ 6.00	\$ 653,400.00
			Conc. Barrier Wall	0	LF	\$ 80.00	\$ -
			1'-6" Concrete Curb and Gutter	0	LF		\$ -
			2'-6" Concrete Curb and Gutter	0	LF		\$ -
			4" Concrete Sidewalk	0	SY		\$ -
			7" Monolithic Islands	0	SY		\$ -
			<b>Fencing</b>				
			Woven Wire	0	LF		\$ -
			Chain Link	0	LF		\$ -
			Erosion Control	79.6	Acres	\$ 12,000.00	\$ 955,200.00
			<b>Signing Interchanges</b>				
			Diamond	0.0	Each		\$ -
			Half Clover	0.0	Each		\$ -
			SPUI	0.0	Each		\$ -
			Flyover	0.0	Each		\$ -
			HOT Specific Signing	1.0	Each	\$ 600,000.00	\$ 600,000.00
			New RR Signal with Gates	0	Each		\$ -
			Rubber Railroad Crossing	0	Each		\$ -
			Upgrade Traffic Signal	0	Each		\$ -
			Traffic Signal (New)	0	Each		\$ -
			Traffic Control	3.6	Miles	\$ 350,000.00	\$ 1,260,000.00
			Thermo and Markers	3.6	Miles	\$ 30,000.00	\$ 108,000.00
			<b>Structures</b>				
			ML / Creek ___'Wx ___'L	0.00	SF		\$ -
			<b>RC Box Culverts</b>				
			Ex. 3@10x10-50'Extension-3'Fill-90'Skew		LF		
			<b>Utility Construction</b>				
			Relocate Existing Water Line	0	LF		\$ -
			Relocate Existing Sewer Line	0	LF		\$ -
			Misc. & Mob (15% Strs&Util)				
			Misc. & Mob (45% Functional)	1	LS		\$ 5,595,500.00
<b>Lgth 3.6 Miles</b>			<b>Contract Cost</b> .....				\$ 18,029,900.00
			<b>E. &amp; C. 15%</b> .....				\$ 2,704,485.00
			<b>Construction Cost</b> .....				<b>\$ 20,734,385.00</b>

**Table 2-3: HOT Lane Extension Only (2009 Dollars)**  
(NC-73 to Catawba Avenue)

Line Item	Des	Sec No.	Description	Quantity	Unit	Price	Amount
			Clearing and Grubbing	43.5	Acre	\$ 12,000.00	\$ 522,000.00
			Earthwork	50,900	CY	\$ 8.00	\$ 407,200.00
			Drainage Existing Location	3.10	Miles	\$ 250,000.00	\$ 775,000.00
			Fine Grading	130,800	SY	\$ 1.50	\$ 196,200.00
			Pavement Widening	94,500	SY	\$ 52.00	\$ 4,914,000.00
			New Pavement	0	SY		\$ -
			Pavement Resurfacing	123,500	SY	\$ 7.00	\$ 864,500.00
			____ "Average Asphalt Wedging	0	SY		\$ -
			Subgrade Stabilization	94,500	SY	\$ 6.00	\$ 567,000.00
			Conc. Barrier Wall	3,200	LF	\$ 80.00	\$ 256,000.00
			1'-6" Concrete Curb and Gutter	0	LF		\$ -
			2'-6" Concrete Curb and Gutter	0	LF		\$ -
			4" Concrete Sidewalk	0	SY		\$ -
			7" Monolithic Islands	0	SY		\$ -
			<b>Fencing</b>				
			Woven Wire	0	LF		\$ -
			Chain Link	0	LF		\$ -
			Erosion Control	69.1	Acres	\$ 12,000.00	\$ 829,200.00
			<b>Signing Interchanges</b>				
			Diamond	0.0	Each		\$ -
			Half Clover	0.0	Each		\$ -
			SPUI	0.0	Each		\$ -
			Flyover	0.0	Each		\$ -
			HOT Specific Signing	1.0	Each	\$ 460,000.00	\$ 460,000.00
			New RR Signal with Gates	0	Each		\$ -
			Rubber Railroad Crossing	0	Each		\$ -
			Upgrade Traffic Signal	0	Each		\$ -
			Traffic Signal (New)	0	Each		\$ -
			Traffic Control	3.1	Miles	\$ 350,000.00	\$ 1,085,000.00
			Thermo and Markers	3.1	Miles	\$ 30,000.00	\$ 93,000.00
			<b>Structures</b>				
			ML / Creek ____ "Wx ____ 'L	0.00	SF		\$ -
			<b>RC Box Culverts</b>				
			Ex. 3@10x10-50'Extension-3'Fill-90Ske	36	LF	\$ 3,000.00	\$ 108,000.00
			<b>Utility Construction</b>				
			Relocate Existing Water Line	0	LF		\$ -
			Relocate Existing Sewer Line	0	LF		\$ -
			Misc. & Mob (15% Strs&Util)	1	LS		\$ 16,300.00
			Misc. & Mob (45% Functional)	1	LS		\$ 4,940,000.00

<b>Lgth 3.1 Miles</b>	<b>Contract Cost .....</b>	<b>\$ 16,033,400.00</b>
	<b>E. &amp; C. 15% .....</b>	<b>\$ 2,405,010.00</b>
	<b>Construction Cost .....</b>	<b>\$ 18,438,410.00</b>



**Table 2-4: HOT Lane and Additional General Purpose Lane in each Direction (2009 Dollars)**  
(North of Hambright Road to NC-73)

Line Item	Des	Sec No.	Description	Quantity	Unit	Price	Amount
			Clearing and Grubbing	73.1	Acre	\$ 12,000.00	\$ 877,200.00
			Earthwork	98,400	CY	\$ 8.00	\$ 787,200.00
			Drainage Existing Location	4.50	Miles	\$ 250,000.00	\$ 1,125,000.00
			Fine Grading	238,700	SY	\$ 1.50	\$ 358,050.00
			Pavement Widening	186,300	SY	\$ 52.00	\$ 9,687,600.00
			New Pavement	0	SY		\$ -
			Pavement Resurfacing	177,900	SY	\$ 7.00	\$ 1,245,300.00
			___ "Average Asphalt Wedging	0	SY		\$ -
			Subgrade Stabilization	186,300	SY	\$ 6.00	\$ 1,117,800.00
			Conc. Barrier Wall	0	LF	\$ 80.00	\$ -
			1'-6" Concrete Curb and Gutter	0	LF		\$ -
			2'-6" Concrete Curb and Gutter	0	LF		\$ -
			4" Concrete Sidewalk	0	SY		\$ -
			7" Monolithic Islands	0	SY		\$ -
			<b>Fencing</b>				
			Woven Wire	0	LF		\$ -
			Chain Link	0	LF		\$ -
			Erosion Control	110.0	Acres	\$ 12,000.00	\$ 1,320,000.00
			<b>Signing Interchanges</b>				
			Diamond	0.0	Each		\$ -
			Half Clover	0.0	Each		\$ -
			SPUI	0.0	Each		\$ -
			Flyover	0.0	Each		\$ -
			HOT Specific Signing	1.0	Each	\$ 600,000.00	\$ 600,000.00
			New RR Signal with Gates	0	Each		\$ -
			Rubber Railroad Crossing	0	Each		\$ -
			Upgrade Traffic Signal	0	Each		\$ -
			Traffic Signal (New)	0	Each		\$ -
			Traffic Control	4.50	Miles	\$ 450,000.00	\$ 2,025,000.00
			Thermo and Markers	4.50	Miles	\$ 40,000.00	\$ 180,000.00
			<b>Structures</b>				
			ML / Creek ___'Wx ___'L	0.00	SF		\$ -
			<b>RC Box Culverts</b>				
			Ex. 3@10x10-50'Extension-3'Fill-90Skew		LF		
			<b>Utility Construction</b>				
			Relocate Existing Water Line	0	LF		\$ -
			Relocate Existing Sewer Line	0	LF		\$ -
			Misc. & Mob (15% Strs&Util)				
			Misc. & Mob (45% Functional)	1	LS		\$ 8,695,000.00
<b>Lgth 4.5 Miles</b>			<b>Contract Cost</b> .....				\$ 28,018,150.00
			<b>E. &amp; C. 15%</b> .....				\$ 4,202,722.50
			<b>Construction Cost</b> .....				<b>\$ 32,220,872.50</b>

**Table 2-5: HOT Lane and Additional General Purpose Lane in each Direction (2009 Dollars)**  
(NC-73 to Langtree Road)

Line Item	Des	Sec No.	Description	Quantity	Unit	Price	Amount
			Clearing and Grubbing	68.2	Acre	\$ 12,000.00	\$ 818,400.00
			Earthwork	117,600	CY	\$ 8.00	\$ 940,800.00
			Drainage Existing Location	6.00	Miles	\$ 250,000.00	\$ 1,500,000.00
			Fine Grading	260,400	SY	\$ 1.50	\$ 390,600.00
			Pavement Widening	221,000	SY	\$ 52.00	\$ 11,492,000.00
			New Pavement	0	SY		\$ -
			Pavement Resurfacing	239,500	SY	\$ 7.00	\$ 1,676,500.00
			3" Average Asphalt Wedging	0	SY		\$ -
			Subgrade Stabilization	221,000	SY	\$ 6.00	\$ 1,326,000.00
			Conc. Barrier Wall	31,700	LF	\$ 80.00	\$ 2,536,000.00
			1'-6" Concrete Curb and Gutter	0	LF		\$ -
			2'-6" Concrete Curb and Gutter	0	LF		\$ -
			4" Concrete Sidewalk	0	SY		\$ -
			7" Monolithic Islands	0	SY		\$ -
			<b>Fencing</b>				
			Woven Wire	0	LF		\$ -
			Chain Link	0	LF		\$ -
			Erosion Control	118.0	Acres	\$ 12,000.00	\$ 1,416,000.00
			<b>Signing Interchanges</b>				
			Diamond	0.0	Each		\$ -
			Half Clover	0.0	Each		\$ -
			SPUI	0.0	Each		\$ -
			Flyover	0.0	Each		\$ -
			HOT Specific Signing	1.0	Each	\$ 620,000.00	\$ 620,000.00
			New RR Signal with Gates	0	Each		\$ -
			Rubber Railroad Crossing	0	Each		\$ -
			Upgrade Traffic Signal	0	Each		\$ -
			Traffic Signal (New)	0	Each		\$ -
			Traffic Control	6.00	Miles	\$ 450,000.00	\$ 2,700,000.00
			Thermo and Markers	6.00	Miles	\$ 40,000.00	\$ 240,000.00
			<b>Structures</b>				
			ML / Creek ____'Wx ____'L	0.00	SF		\$ -
			<b>RC Box Culverts</b>				
			Ex. 3@10x10-50'Extension-3'Fill-90Ske	60	LF	\$ 3,000.00	\$ 180,000.00
			<b>Utility Construction</b>				
			Relocate Existing Water Line	0	LF		\$ -
			Relocate Existing Sewer Line	0	LF		\$ -
			Misc. & Mob (15% Strs&Util)	1	LS		\$ 27,100.00
			Misc. & Mob (45% Functional)	1	LS		\$ 11,550,000.00
<b>Lgth 6.0 Miles</b>				<b>Contract Cost</b>			\$ 37,413,400.00
				<b>E. &amp; C. 15%</b>			\$ 5,612,010.00
				<b>Construction Cost</b>			<b>\$ 43,025,410.00</b>

**Table 2-6: Summary of Total Costs (2009 Dollars)**

<b>Alternative 1: <u>HOT Lane Only</u></b>	<b>Cost in 2009 Dollars</b>	<b>Alternative 2: <u>HOT + GP Lane</u></b>	<b>Cost in 2009 Dollars</b>
Mt. Holly- Huntersville Road to NC-73	\$ 20,700,000	North of Hambright Road to NC-73	\$ 32,200,000
NC-73 to Catawba Avenue	\$ 18,400,000	NC-73 to Langtree Road	\$ 43,000,000
Toll & ITS Equipment	\$11,200,000	Toll & ITS Equipment	\$12,700,000
<b>TOTAL</b>	<b>\$ 50,300,000</b>	<b>TOTAL</b>	<b>\$ 87,900,000</b>

## **2.2 ROADWAY CAPITAL MAINTENANCE COSTS**

The HOT lane scenarios being examined involve both conversion of existing HOV lanes and new construction. In addition to the capital costs discussed in the preceding section, capital maintenance costs (sometimes referred to as major renovation and rehabilitation) have been estimated.

An ongoing debate exists on how capital maintenance on HOT lane facilities should be financed. Most traditional toll financial analyses assume these costs are borne by the facility and are generally paid from free cash flow after debt service payments have been made. Regardless of whether debt is issued for the facility, there is a legitimate question of whether the burden of paying these costs should be allocated to the HOT lane system. This debate goes to the fundamental purpose of a HOT lane versus a stand-alone toll road – which in the case of I-77 is to provide congestion relief from general purpose lanes and encourage persons to share rides or use public transportation.

HOV lanes can be converted to HOT lanes to create an additional congestion management tool. The fact that a HOT lane facility produces revenue does not mean it should be enough to cover some or all of the project's costs for the facility to be considered feasible or functional. Sub-task 2.G, Financial and Economic Feasibility, will discuss how capital costs associated with HOT lanes implementation can be financed.

Facility capital maintenance costs are presented to illustrate the amount of funds needed over time to keep the HOT lane in optimal condition. The costs outlined in **Table 2-7** are for two cycles of capital maintenance that should keep the roadway in good condition for over 30 years.

The first capital maintenance project would be needed when the lane is about 12 years old. This project will consist of a surface seal to fill cracks in the roadway and re-establish the surface texture. The second capital maintenance project would be needed

when the lane is about 24 years old, and would involve milling the surface of the roadway off and replacing it with a two-inch overlay of new pavement.

**Table 2-7: Periodic Capital Maintenance Costs (2009 Dollars)**

	Unit Cost (per lane mile)	Frequency (years)	Existing HOV converted to HOT	Extension to Exit 25	Extension to Exit 28	Extension to Exit 30	Total System
Surface Sealing	\$50,000	12	\$ 792,000	\$ 630,000	\$ 348,000	\$ 180,000	<b>\$ 1,950,000</b>
Mill & Overlay	\$70,000	24	\$ 1,108,800	\$ 882,000	\$ 487,200	\$ 252,000	<b>\$ 2,730,000</b>
<b>Cumulative Costs</b>			<b>\$ 1,108,800</b>	<b>\$ 1,990,800</b>	<b>\$ 2,478,000</b>	<b>\$ 2,730,000</b>	

\* Contingency of 20% included

The mill and overlay would provide adequate roadway surface for an additional 12 years, though during this time, the roadway's sub-surface would begin to break down and eventually the entire roadway would need to be replaced (approximately 30 to 35 years from initial construction). Escalating the figures in **Table 2-7** at a rate of 5 percent to the appropriate years when these projects would be undertaken would increase the costs shown in this table considerably. For instance, if the full 32.5-mile system was completed in 2012, the cost to do a surface sealing 12 years later in 2024 would be about \$4.1 million in year-of-expenditure dollars.

## 3.0 OPERATIONS & MAINTENANCE COSTS

### 3.1 ROADWAY O&M COSTS

Roadway O&M cost estimates are based on a current NCDOT estimate of \$9,000 per lane-mile per year. This cost would cover surface upkeep, sign repair, snow removal, fence repair, landscaping and other related expenses. **Table 3-1** summarizes the annual roadway O&M costs for each scenario.

**Table 3-1: Roadway O&M Costs (HOT/HOV Scenarios)**

	Existing HOV	Existing HOV extended to Exit 25	Existing HOV extended to Exit 28	Existing HOV extended to Exit 30	Total System
Roadway Maintenance	\$118,800	\$94,500	\$52,200	\$27,000	\$ 292,500
Contingency (20%)	\$23,760	\$18,900	\$10,440	\$5,400	\$ 58,500
<b>Total Cost</b>	<b>142,560</b>	<b>113,400</b>	<b>62,640</b>	<b>32,400</b>	<b>\$ 351,000</b>
<b>Cumulative Costs</b>	<b>\$142,560</b>	<b>\$255,960</b>	<b>\$318,600</b>	<b>\$351,000</b>	

### 3.2 TOLLING SYSTEM O&M COSTS

The cost to operate and maintain the tolling system can be divided into two main categories: fixed costs and variable costs. Fixed costs are generally contract or personnel related while variable costs are related to transaction processing and will increase with the number of transactions.

#### Fixed Tolling O&M Costs

Fixed costs for the HOT lane system are shown in **Table 3-2**. These include system component upkeep, contracts for enforcement and Incident Management Assistance Patrol (IMAP), and additional marketing and technical support staff.

**Table 3-2: Tolling Infrastructure and ITS System O&M (HOT)**

	Convert HOV to HOT	Extension to Exit 25	Extension to Exit 28	Extension to Exit 30	Total System
Tolling Maintenance	\$91,100	\$60,700	\$30,400	\$30,400	\$ 212,600
ITS Maintenance	\$108,500	\$83,400	\$46,100	\$23,800	\$ 261,800
Enforcement	\$105,000	NA	NA	NA	\$ 105,000
IMAP Payment	\$121,800	\$96,900	\$53,500	\$27,700	\$ 299,900
Staffing Costs	\$140,000	NA	NA	NA	\$ 140,000
Contingency (15%)	\$85,000	\$36,200	\$19,500	\$12,300	\$ 153,000
<b>Total Cost (2009)</b>	<b>\$651,400</b>	<b>\$277,200</b>	<b>\$149,500</b>	<b>\$94,200</b>	<b>\$ 1,172,300</b>
<b>Total Cost (2013)</b>	<b>\$733,200</b>	<b>\$312,000</b>	<b>\$168,300</b>	<b>\$106,000</b>	<b>\$ 1,319,500</b>
<b>Cumulative Costs (2009)</b>	<b>\$651,400</b>	<b>\$928,600</b>	<b>\$1,078,100</b>	<b>\$1,172,300</b>	

**System Equipment Maintenance** - Maintenance costs for the tolling system are expected to be about 15 percent of capital expenditures for the tolling point equipment, excluding gantries. The ITS system maintenance is anticipated to be about 5 percent of capital expenditures.

**Enforcement and Courtesy Patrol O&M Costs** – The average cost for an enforcement patrol was estimated at \$105,000 per year based on input from the North Carolina State Highway Patrol (NCSHP). One additional patrol will be required on the corridor to enforce occupancy requirements and to reduce weaving in and out of the HOT lanes where access is prohibited. All vehicles will be required to have a switchable transponder that will designate them as an HOV or a toll-paying user. Video tolling will be used to identify vehicles without transponders; therefore, one full-day patrol equivalent should be sufficient for each of the HOT lane scenarios.

In addition to expanded enforcement, additional courtesy patrol service should be budgeted. For the *Triangle Express* (North Carolina's first toll facility which is under construction), NCDOT/NCTA would contract with NCDOT's IMAP for these services. NCDOT/NCTA's proposed contract for IMAP services equals about \$11,400 per lane-mile per year. A unit cost of 80 percent of this figure was assumed for the I-77 corridor because IMAP service is already being provided and the cost to increase frequency should be less than operating service where it had not been previously provided. As such, \$9,200 per year per lane-mile was assumed as the unit cost for IMAP service for I-77 HOT lanes scenarios.

**Back Office Operations Costs** - A back office will be required to handle transactions, provide customer service, and provide facilities for monitoring of the toll system. As discussed in the following section, NCDOT/NCTA has been assumed to operate the HOT lane system for a revenue share per transaction. This cost includes all labor associated with the system's operation, except local staff needed for marketing and technical support. **Table 3-3** outlines a few additional positions expected to be needed to promote the facility and transponder use and handle equipment maintenance on the facility.

**Table 3-3: Labor Costs Added to NCDOT/NCTA Back Office Operations**

	Salary (FTE)	FTE: All HOT Lane Scenarios	Annual Salary Cost plus Benefits*
Kiosk Salesperson Staff	\$20,000	2	\$56,000
Toll Systems Technician	\$60,000	1	\$84,000
<b>Total Staffing Cost</b>			<b>\$140,000</b>

## Variable Tolling Costs

**Transaction Costs** - Transaction and violation processing costs associated with tolling are shown in **Table 3-4**. The tables provide an annual cost for 2013 based on current assumptions for transactions based on a minimum toll assumption of \$0.10 per mile. The cost to process a normal transponder transaction is estimated to be \$0.10 based on NCDOT/NCTA analysis of their back office operational costs. The cost includes all

transaction processing, customer service, credit card processing fees, and all other facility operations.

**Table 3-4: Transaction Variable Costs**

	Convert HOV to HOT	Extension to Exit 25	Extension to Exit 28	Extension to Exit 30	Total System
Transaction Costs (2013)	\$ 39,900	\$ 96,200	\$ 90,700	\$ 13,600	\$ 240,400
Violation Costs (2013)	\$ 79,700	\$ 192,600	\$ 181,400	\$ 27,100	\$ 480,800
Contingency (15%)	\$ 17,900	\$ 43,300	\$ 40,800	\$ 6,100	\$ 108,100
<b>Total Cost</b>	<b>\$ 137,500</b>	<b>\$ 332,100</b>	<b>\$ 312,900</b>	<b>\$ 46,800</b>	<b>\$ 829,300</b>
<b>Cumulative Costs</b>	<b>\$ 137,500</b>	<b>\$ 469,600</b>	<b>\$ 782,500</b>	<b>\$ 829,300</b>	

**Violation Costs** – Transponder use will be strongly encouraged on the facility. Transponder users will be awarded with discounted toll rates compared to vehicles that enter the facility without the proper transponder equipment. Non-transponder user's vehicles will be photographed with video equipment, known as license plate recognition (LPR), and charged the standard toll. Both the standard and discounted tolls have been calibrated to maximize facility performance and cover associated transaction processing costs.

Based on an assumption of strong ETC penetration due to deep discounting for transponder use, it was assumed that only 10 percent of I-77 HOT lanes users would be processed through video tolling. Of this pool of vehicles, 60 percent are expected to have a readable license plate, receive a billing notice by mail, and pay the standard-rate toll. The remaining 40 percent represent license plates that will be unreadable, vehicle owners whose contact information cannot be found, or users who simply do not pay once they receive the invoice notice. This pool of users is assumed not to pay the toll; therefore, the I-77 HOT lanes facility loses the toll revenue and incurs the cost to process the toll through LPR. The processing cost is assumed to be \$5.00 for each of the non-collectable transactions, representing 4 percent of total transactions. This is reflected in the violation costs listed in **Table 3-4**.

### 3.3 TOTAL OPERATIONS & MAINTENANCE COSTS

**Table 3-5** summarizes the major categories of O&M costs outlined in the above sections providing a total for each HOT facility scenario. A subsequent Project Technical Memorandum discussing financial feasibility will compare costs with expected revenues under each scenario and outline which of these costs could be borne by the facility.

**Table 3-5: Total HOT Facility O&M Costs (2009 Dollars)**

	Convert HOV to HOT	Extension to Exit 25	Extension to Exit 28	Extension to Exit 30	<b>Total System</b>
Total Fixed O&M Costs	\$733,200	\$312,000	\$168,300	\$106,000	<b>\$ 1,319,500</b>
Total Variable O&M Costs	\$137,500	\$332,100	\$312,900	\$46,800	<b>\$ 829,300</b>
<b>Total Toll Road Costs</b>	<b>\$870,700</b>	<b>\$644,100</b>	<b>\$481,200</b>	<b>\$152,800</b>	<b>\$ 2,148,800</b>
<b>Cumulative Toll Road Costs</b>	<b>\$870,700</b>	<b>\$1,514,800</b>	<b>\$1,996,000</b>	<b>\$2,148,800</b>	
<b>Total Roadway Maintenance Costs</b>	<b>\$160,453</b>	<b>\$127,633</b>	<b>\$70,502</b>	<b>\$36,466</b>	<b>\$ 395,054</b>
<b>Cumulative Costs</b>	<b>\$160,453</b>	<b>\$288,085</b>	<b>\$358,587</b>	<b>\$395,054</b>	
<b>Total O&amp;M Costs</b>	<b>\$1,031,153</b>	<b>\$771,733</b>	<b>\$551,702</b>	<b>\$189,266</b>	<b>\$ 2,543,854</b>
<b>Cumulative Costs</b>	<b>\$1,031,153</b>	<b>\$1,802,885</b>	<b>\$2,354,587</b>	<b>\$2,543,854</b>	